Hake MSE process update

JMC meeting

July 31, 2018

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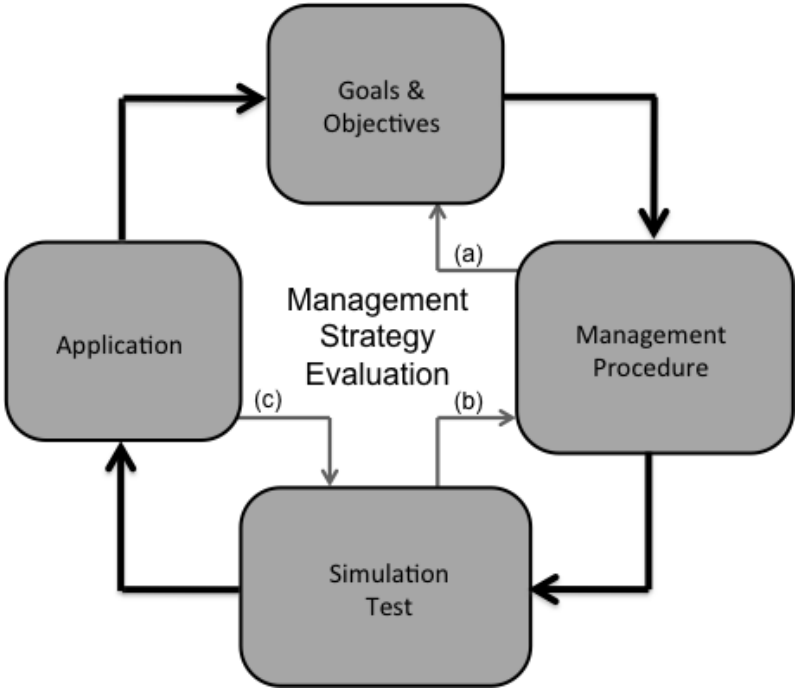
Reminder: MSE is a process

- Simulates the entire management process
  - Data collection
  - Assessment
  - Application of harvest control rules
  - Effect of removals on abundance, distribution, productivity
- Communication throughout the process is key



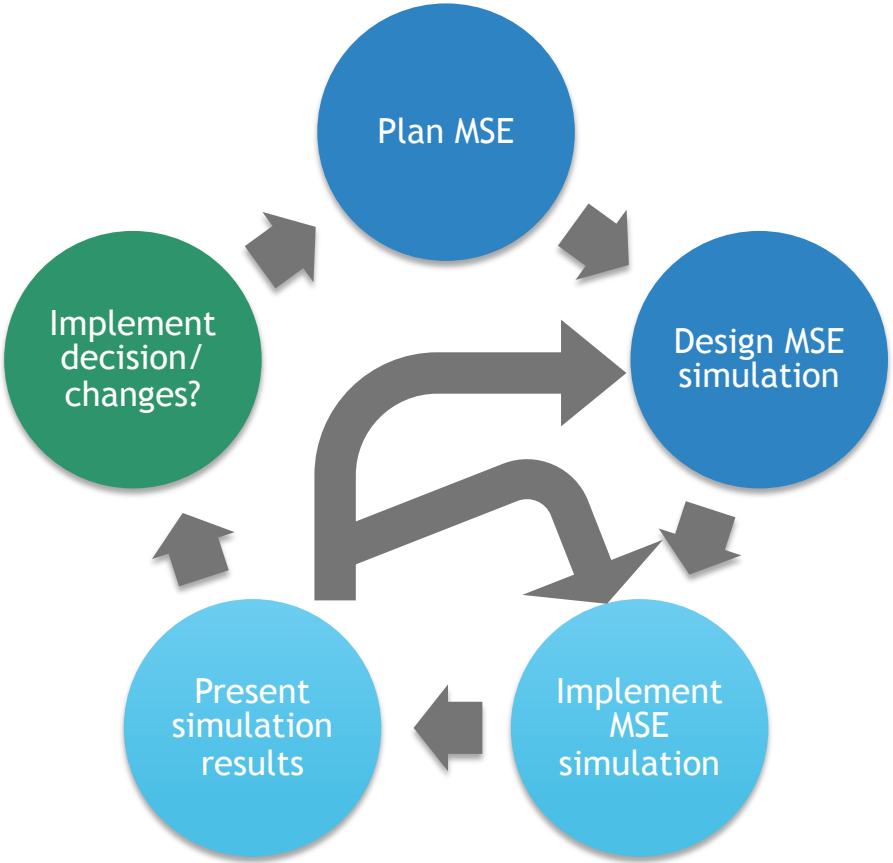
Reminder: MSE is meant to improve strategic decision making

- Testing the performance of management procedures (data collection, assessment, application of harvest strategies) over:
  - Many replicate “futures”
  - Future scenarios capturing “things we can’t control”, e.g. changes in productivity, recruitment, natural mortality, spatial distribution
  - Alternative hypotheses about how the fishery system functions
- Testing management procedures first in a virtual world, before considering implementing them the real world is part of due diligence
- MSE is not meant to inform tactical decision-making

Outline

- Review workplan and timeline
- Progress since March
  - MSE Working Group calls
  - Operating model development

Work plan for this iteration of Hake MSE (thru Dec 2019)


Plan MSE
Design MSE simulation
Implement MSE simulation
Present simulation results
Implement decision/ changes?

Plan and Design I

1. Establish project team and MSE Work group, roles and responsibilities, communication strategies, work plan
2. Establish goals for this iteration of the MSE

JMC's stated MSE goals

- Evaluate the performance of current hake management procedures under alternative hypotheses about current and future environmental conditions
- Better understand the effects of hake distribution and movement on both countries' ability to catch fish
- Better understand how fishing in each country affects the availability of fish to the other country in future years

Plan and Design II

3. ✓ Review goals and objectives of managers with feedback from MSE working group
4. ✓ Review performance metrics with feedback from MSE working group
5.  Develop environmental scenarios
6.  Identify other types of scenarios (?)
7.  Develop operating and estimation models

Implement MSE simulation




8. Develop computer code for closed loop simulation
9. Parameterize operating models
10. Simulate each management strategy with each operating model and summarize and interpret performance metrics
11. Develop communication tools for simulation results

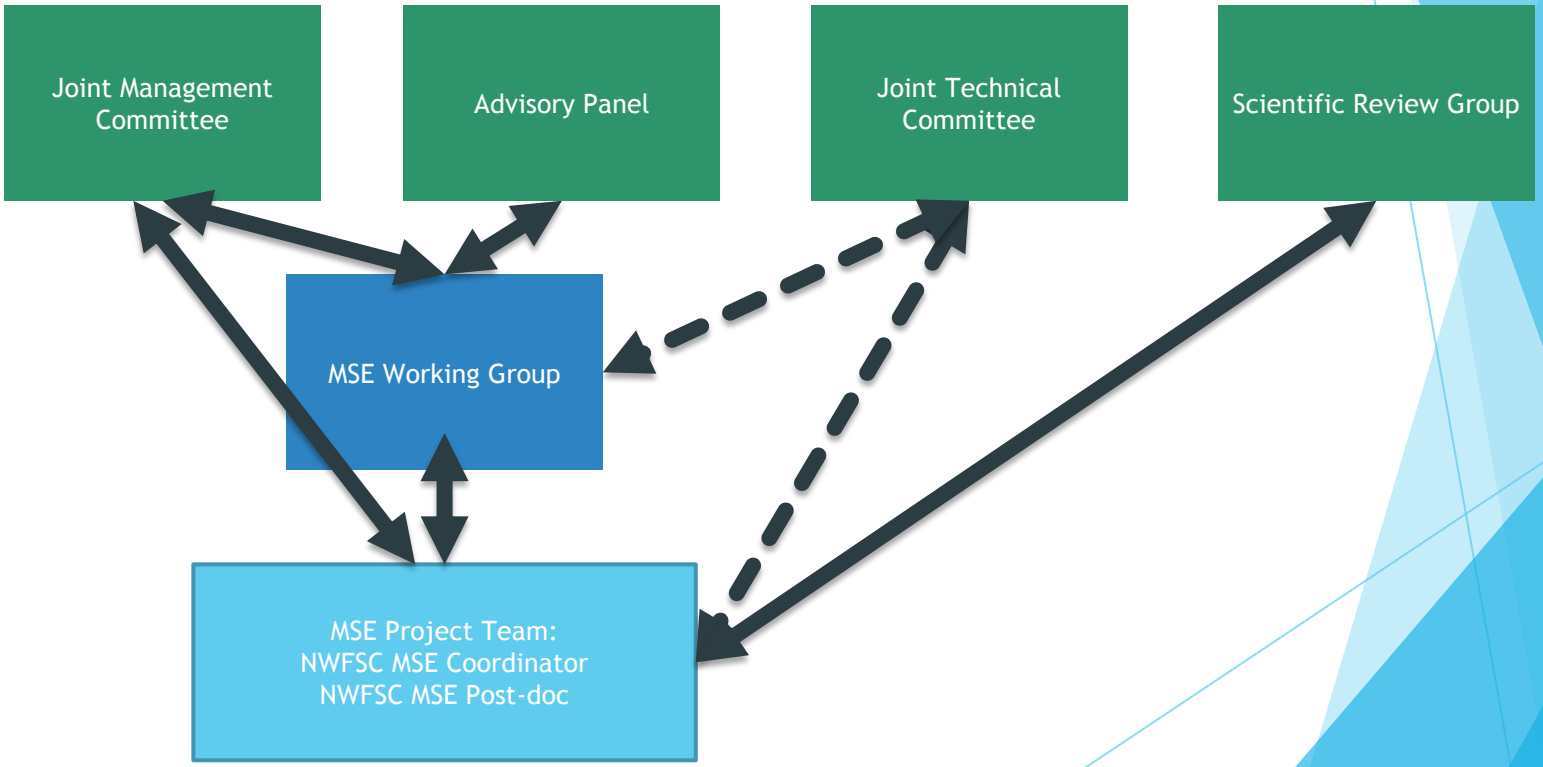
12. Present simulation results

- *Deliverables:*
  - *First iteration, with a single non-conditioned model - JMC summer meeting 2018*
  - *Second iteration, with at least one conditioned model - Feb/March 2019*
  - *Third iteration, with multiple conditioned models - Aug 2019*

13. Technical documentation of results – by Dec 2019

MSE Working Group Progress

Proposed communication plan for MSE

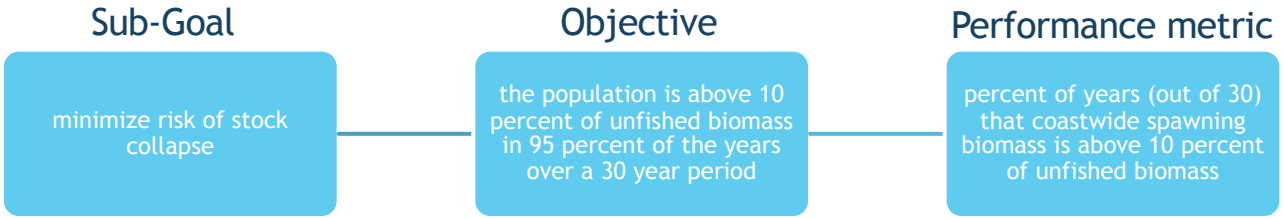


MSE Working Group call topics

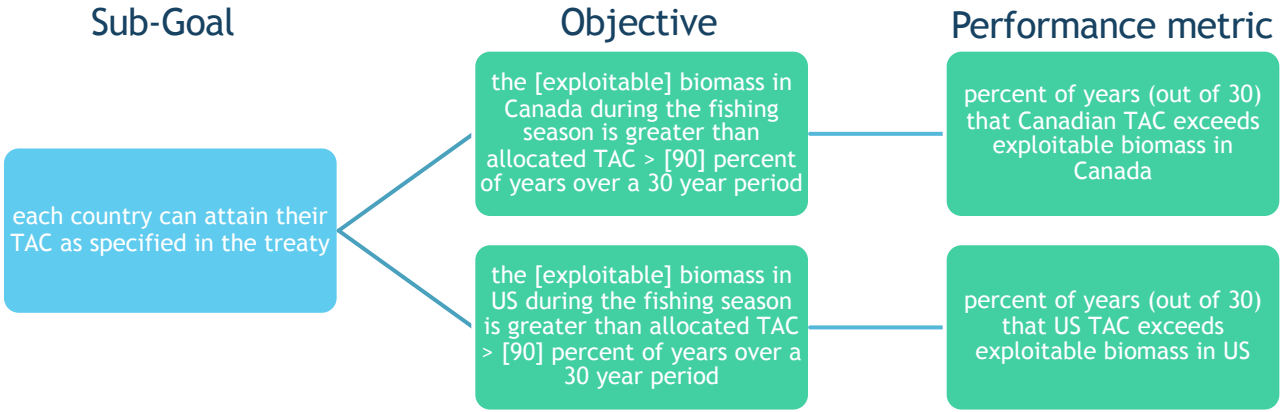
- Management objectives and performance indicators
- Operating model structure and FATE Hake hypotheses
- Scenarios for uncertainty

1. Specifying objectives and performance metrics for the MSE

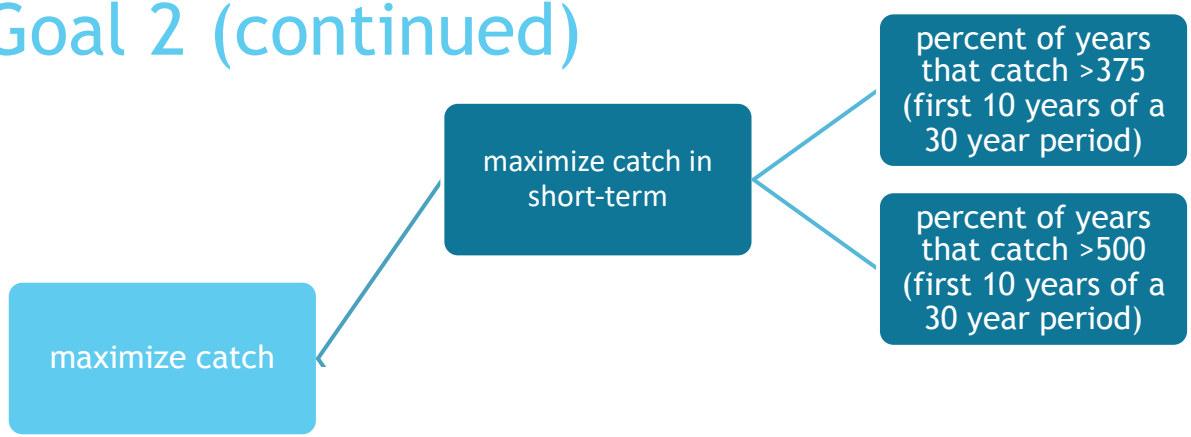
Goal 1: Manage the Pacific hake resource in a precautionary and sustainable manor



Goal 2: Ensure both parties can receive their intended benefits under the treaty



Goal 2 (continued)



Sub-Goal

Objective

Performance metric

2. Generating hypotheses for MSE operating models and FATE Hake poject

Part I. Generating hypotheses about what influences the distribution of hake within and among years to inform the FATE Hake project

What factors do you think influence where hake are located within a year?

- feed or prey (shrimp, krill, and YOY hake)
- predation
- **water temperature**
- water clarity
- **prevailing winds**
- **correlation between freshwater outflow of the Columbia**
- seasonal east-west movement patterns in Canada

What do you think causes changes in hake spatial distribution across years?

- Observations of a dramatic shift (reduction) in hake biomass and larger/older size classes in Canadian waters, comparing the 1980s and 1990s to the period from 2000 to present
- Northward shift in fishing grounds in Canada since 2000
- Potential drivers of hake distribution that were mentioned: prey availability, temperature, fishing

Why do you think hake are distributed further north in some years?

- Observations of appearance of 2006 and 2008 year classes in Canada, but were perceived as less abundant as ages 3 and 4 in US waters. This may suggest migration patterns could be more complicated than a north-south pattern
- Other factors that emerged in the discussion:
  - Distinguishing between the distribution of fish, accessible fish and catch (external factors like market drivers and processors may influence where, when, and how much fish are caught)
  - Increase in length of the fishing season since the 1980s, particularly in Canada--caused by technological changes, shifts in processing, and where the fish are occurring. US side has been more static in processing.
  - Increasing depth of fishing

Part II. Generate ideas about alternative operating model structures for the MSE

What assumptions do you think are the most constraining or incorrect? What alternative OM configurations should we consider?

- Performance metrics should be calculated over shorter and longer time scales
- Movement parameters (transition matrix) is fixed across years for now, but this could be made time-varying
- Movement increases with age based on assumption that swimming distance scales with size
- Consider including some resident fish that don't move between the 2 model boxes

How do you think catches should be implemented in the model based on the harvest control rule?

- Treat catch as scenarios, e.g.:
  - Assume total allowable catch from the HCR is removed from the population
  - Assume 85 percent of total allowable catch from HCR is removed (allow for 15 percent carryover the following year)
  - Assume some lower percentage based on historical decisions
- Consider exploring management strategies that focus more strongly on particular age classes (e.g., harvest only 1 year olds or harvest only 4 years olds)

Do you think seasonality in catches affects the population dynamics?

- In Canada, slower fishing at the beginning and end of the season, peaks in summer, and age proportions in the catch can also change by season
- Fish condition also changes with season- they fatten up during the summer

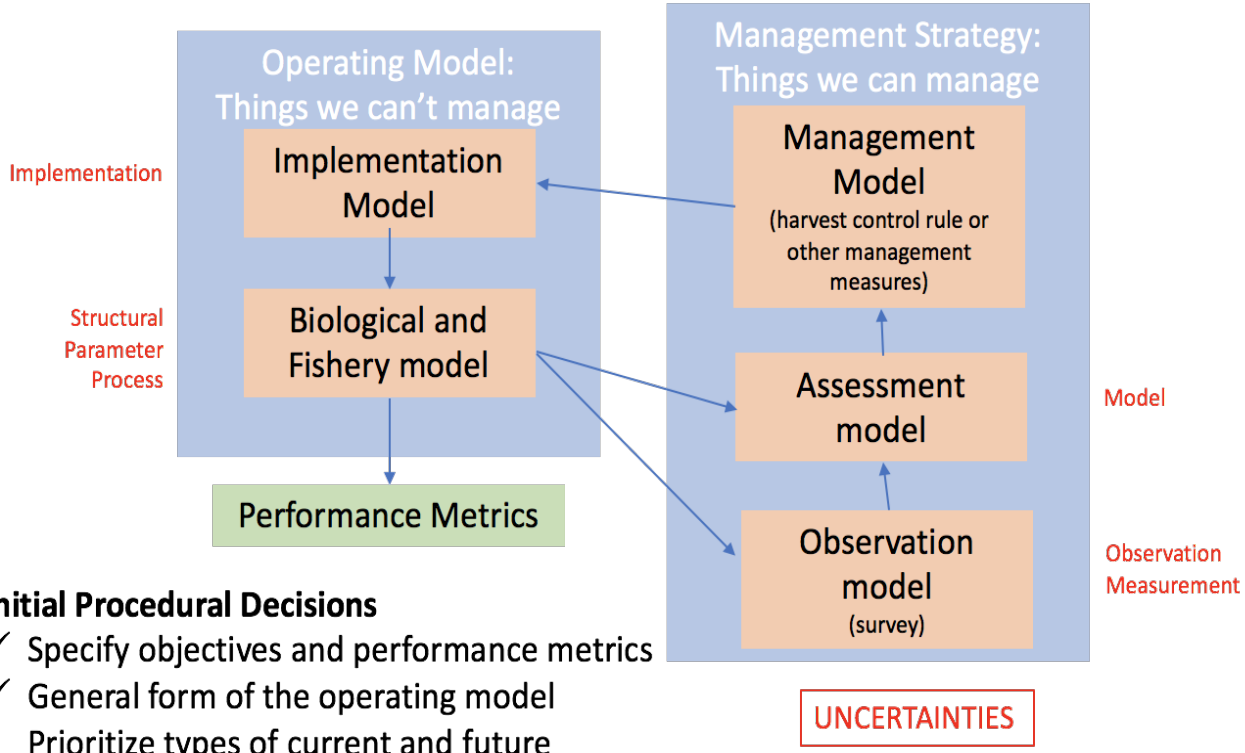
Do you think there are significant differences in fishing gear used in the U.S. and Canada?

Observations of interactions between gear selectivity, availability of fish, and fisher behavioral choices. E.g.,

- In Canada, infrequent age 1 and 2 because they aren't there, mostly movement and not selectivity
- In Canada, age 2 fish are avoided and they don't see many
- In US, small fish are not desirable, but they can be used if they're caught. Equal effort to avoid them. Prevalence is greater in the US and sometimes mixed in with 3 year old fish

3. Prioritizing scenarios of uncertainty for the MSE

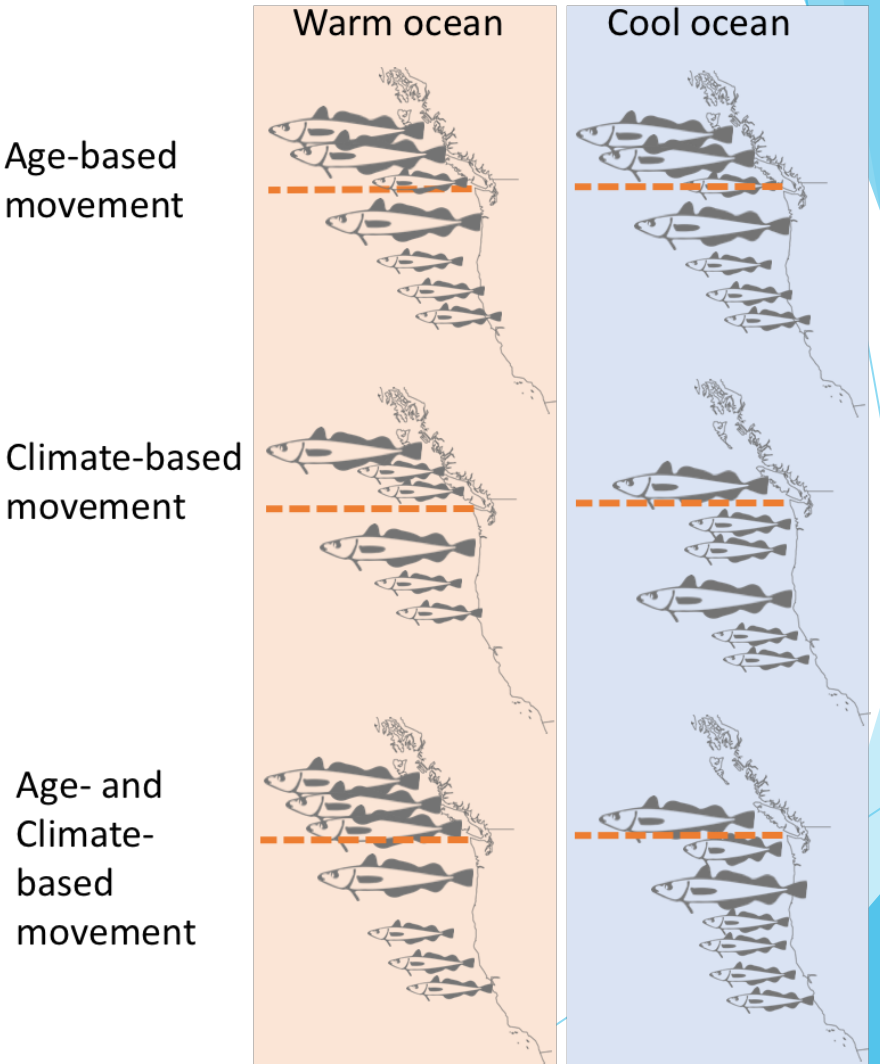
Management Strategy Evaluation



Initial Procedural Decisions

- ✓ Specify objectives and performance metrics
- ✓ General form of the operating model
- • Prioritize types of current and future uncertainty to explore
- • Identify candidate management strategies

Alternative hypotheses for movement (operating models)



Potential hypothesis about the effect of the future *environment on movement:

- Status quo: no change in future environment
- *Trend (continuous increase or decrease) in movement rate with warming conditions
- *Movement may exhibit regime-like patterns or follow an ENSO-like signal
- *Variability in movement could increase in an unpredictable way

*Plausibility for current and future environmental effects will be informed by on-going FATE-funded work

Other scenarios raised for consideration:

- Recruitment scenarios
  - What are the effects of large and small recruitment events?
  - What are the environmental drivers of recruitment and how will future environmental conditions affect recruitment?
- Growth scenarios
  - How could growth change through time with environmental conditions?

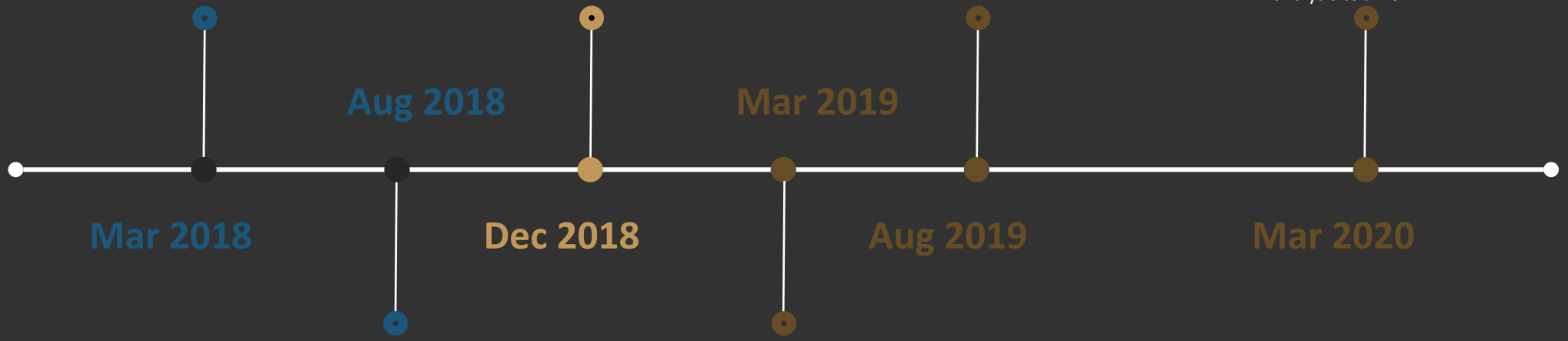
A management strategy evaluation of Pacific hake: simulation model structure, conditioning, and preliminary projections

Nis S. Jacobsen, Aaron M. Berger, Kristin N. Marshall, Ian G. Taylor

Disclaimer

Results show in this presentation are preliminary and should currently not be used for management decisions.

Hake MSE Project Timeline



Project Planning

- Establish MSE project team and MSE working group
- Finalize workplan
- Establish JMC's goals for this iteration of MSE

Model Development

- Develop code to run closed loop simulation
- Parameterize and condition initial operating model

Expand Operating Models

- Develop operating models with environmental drivers of movement
- Preliminary second phase results

Second Phase Results

- Final second phase results with multiple operating models
- Review of second phase analysis by SRG
- Presentation of full analysis to JMC

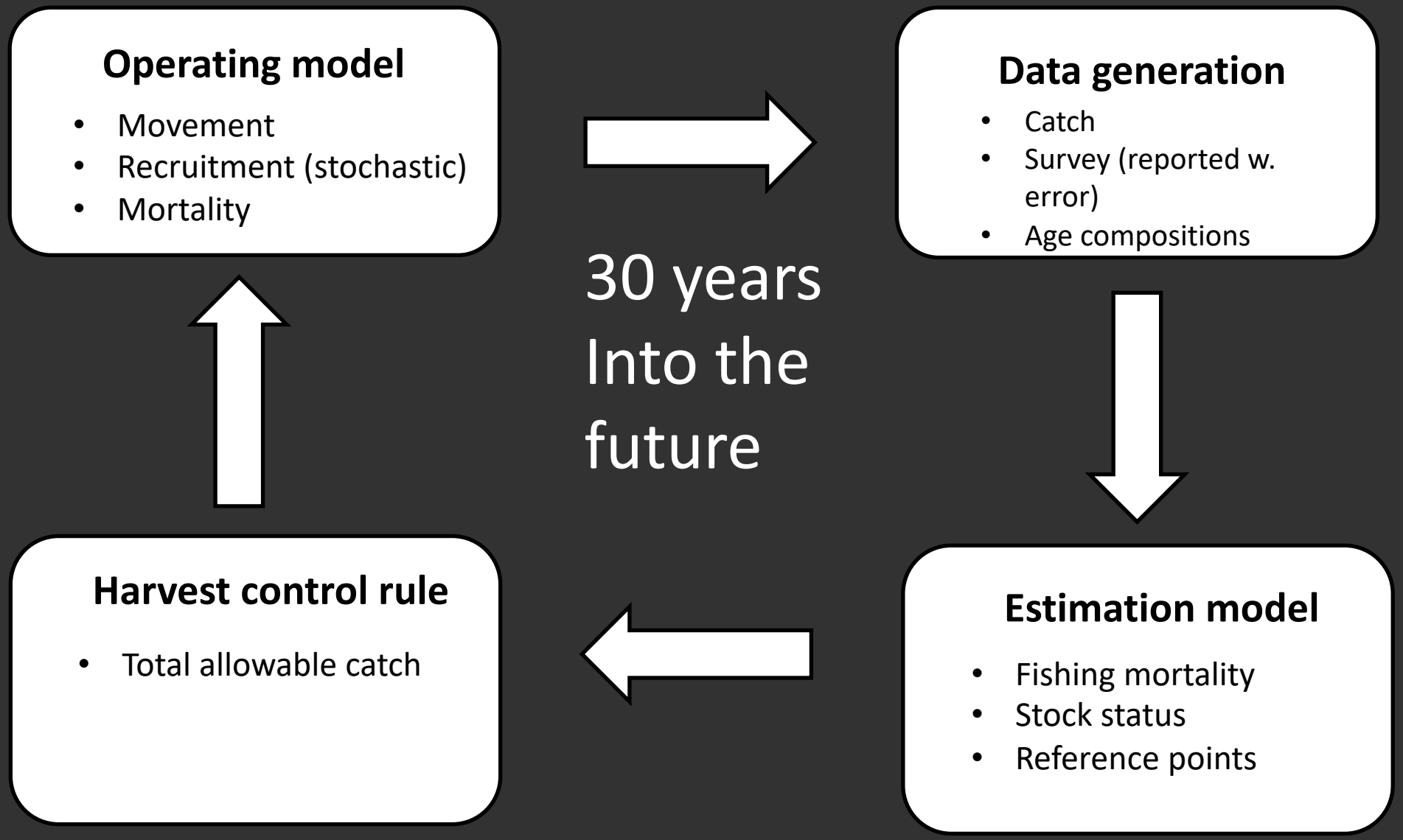
Model Design

- Review and update management objectives and performance metrics
- Specify management procedures to test
- Develop initial environmental scenarios
- Develop initial spatial operating model
- Feedback from JMC on initial operating model structure

First Phase Results

- Develop communication tools for simulation results
- Initial operating model reviewed by SRG
- First phase of results from conditioned operating model shared with JMC

Conceptual Pacific hake MSE simulation framework

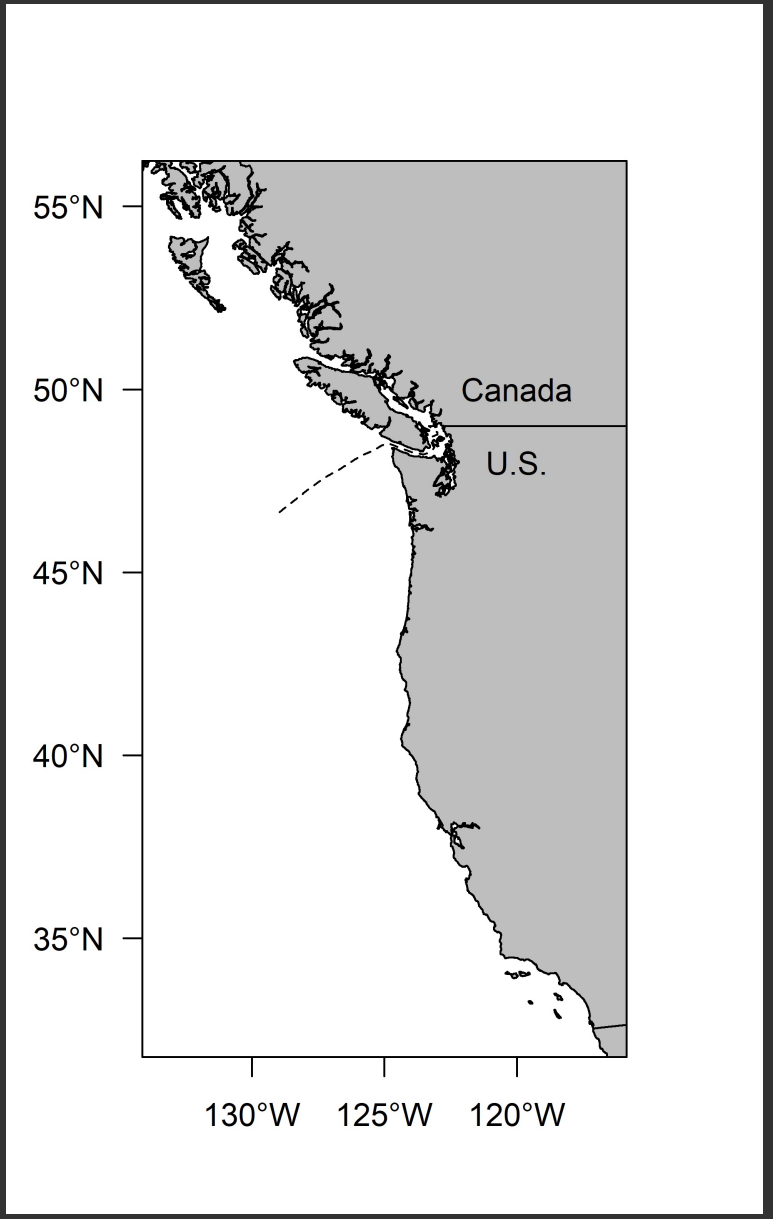


Estimation model

- Standard Stock Synthesis stock assessment model
- Rewritten in TMB for speed, R integration and increased transparency
- Faster than SS, and with possibility of adding random effects

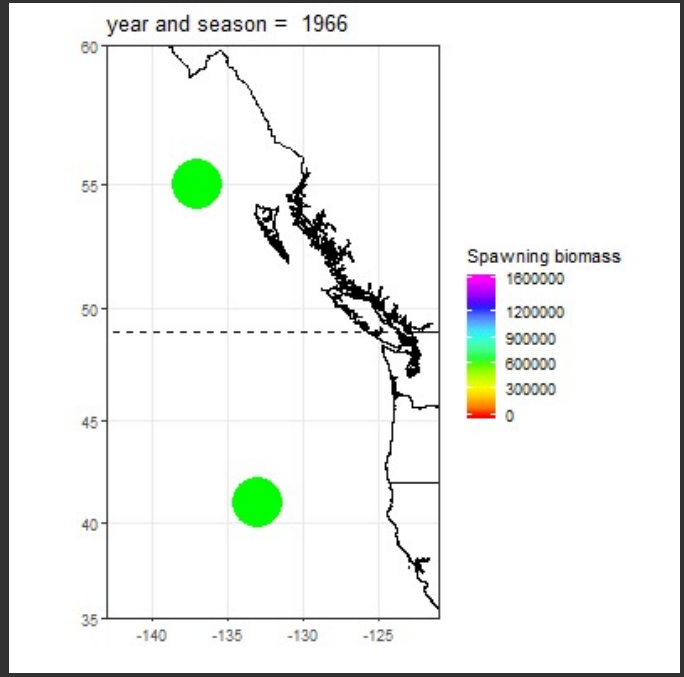
Operating model

- Age based model
- Time scale is four seasons per year
- Spatial: fish movement, fisheries, spawning, selectivity
- Movement happens in every season
- Produces data similar to the data available from the fishery
- Written in a flexible framework to allow exploration of different scenarios and OM configurations
- Conditioned upon available data from survey and fishery
- Written in R



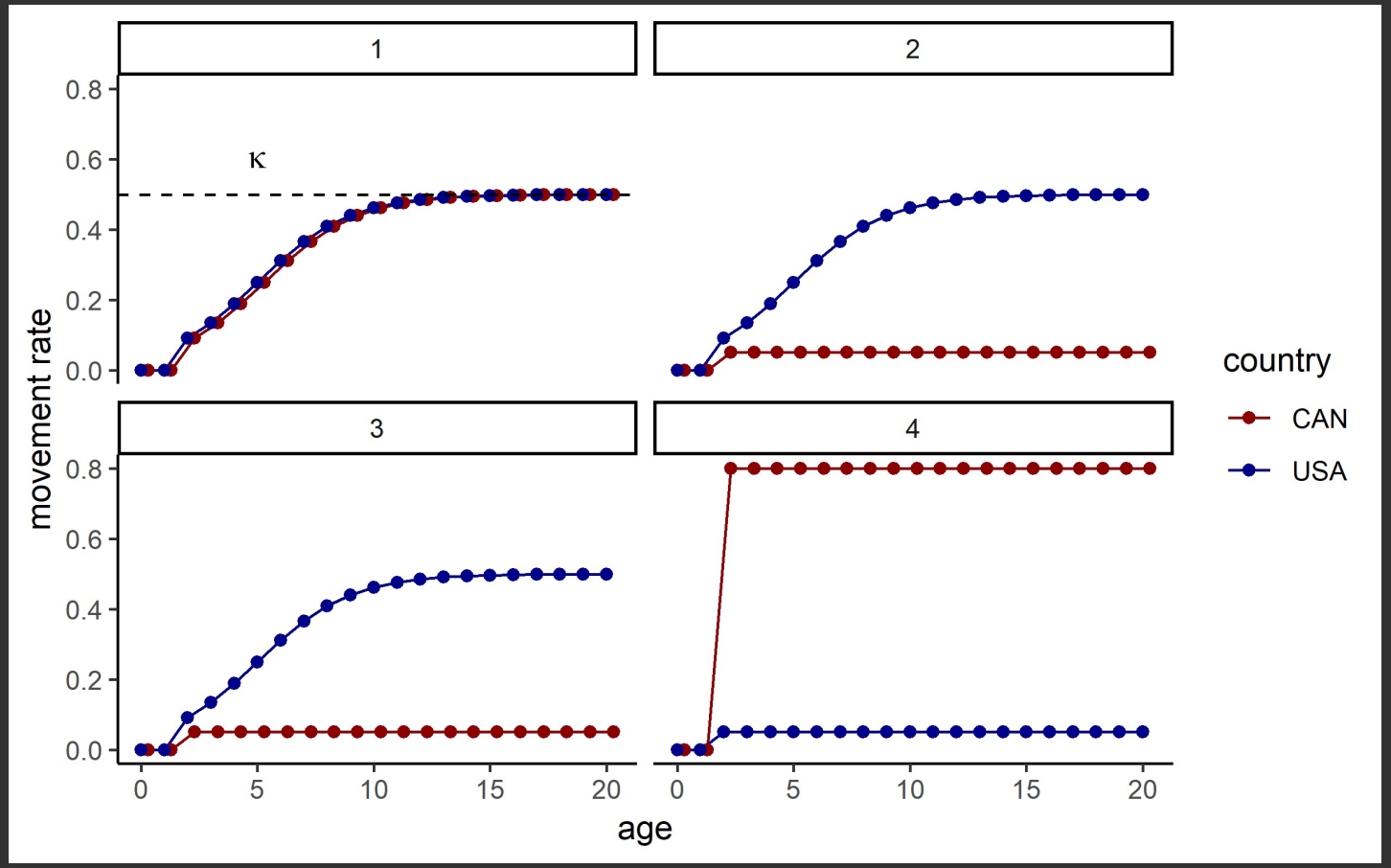
Movement

- Modeled as a fraction of the age group that moves out of an area
- Currently implemented as 2 boxes (they either move north or south) – the software is flexible
- Older individuals have a greater probability to move than smaller ones
- Most spawners move south in the last season of the year to spawn
- (The fish do not move south before spawning)



Seasonal movement parameters

$$\omega_a = \frac{\kappa_i}{1 + e^{-\gamma a - a_{50}}}$$



κ is the maximum movement rate

Spawning

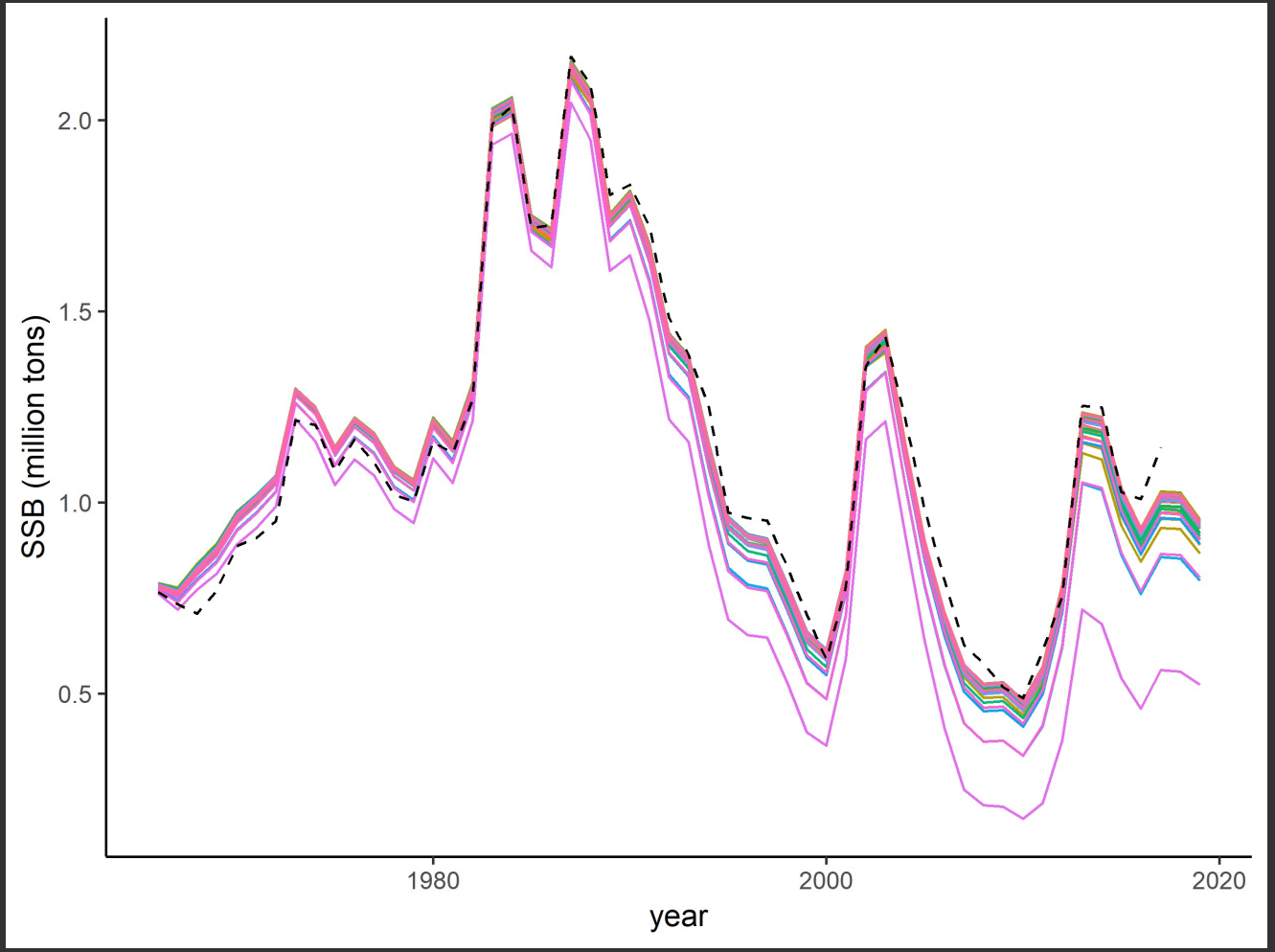
- Beverton Holt with annual recruitment deviations
- Spawning occurs in the beginning of season one
- Stock recruitment relationship is area specific (depends on the spawners in each area) – deviations are the same for all areas
- Recruits (0-1 year) do not move

Photo credit Pete Frey (NWFSC)

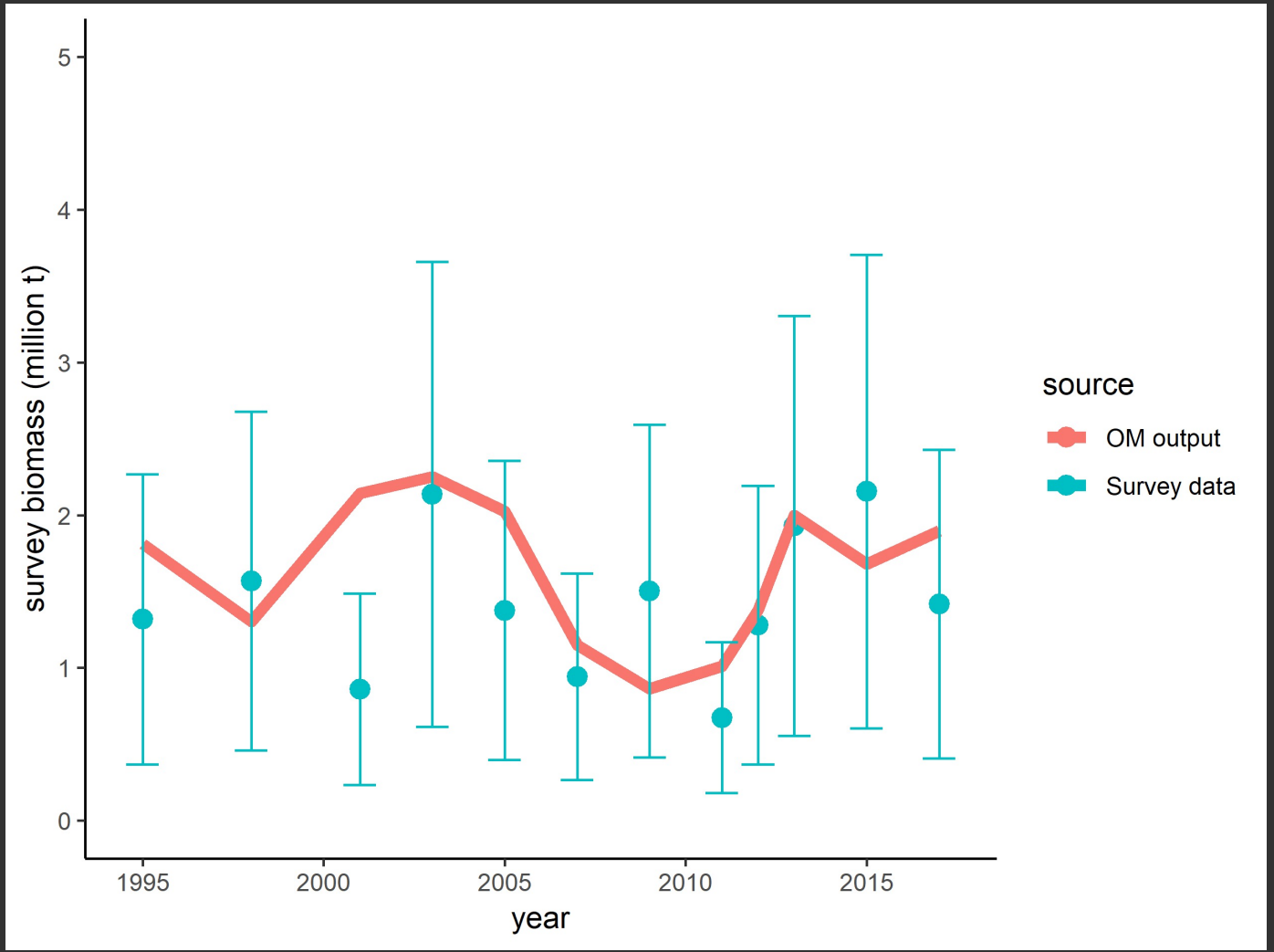
Fisheries

- Catch is divided by areas according to the Treaty
- The operating model calculates the fishing mortality in each area depending on the catch distribution per season
- Selectivity can be area specific or constant
- Catches occur predominantly in season 2 and 3

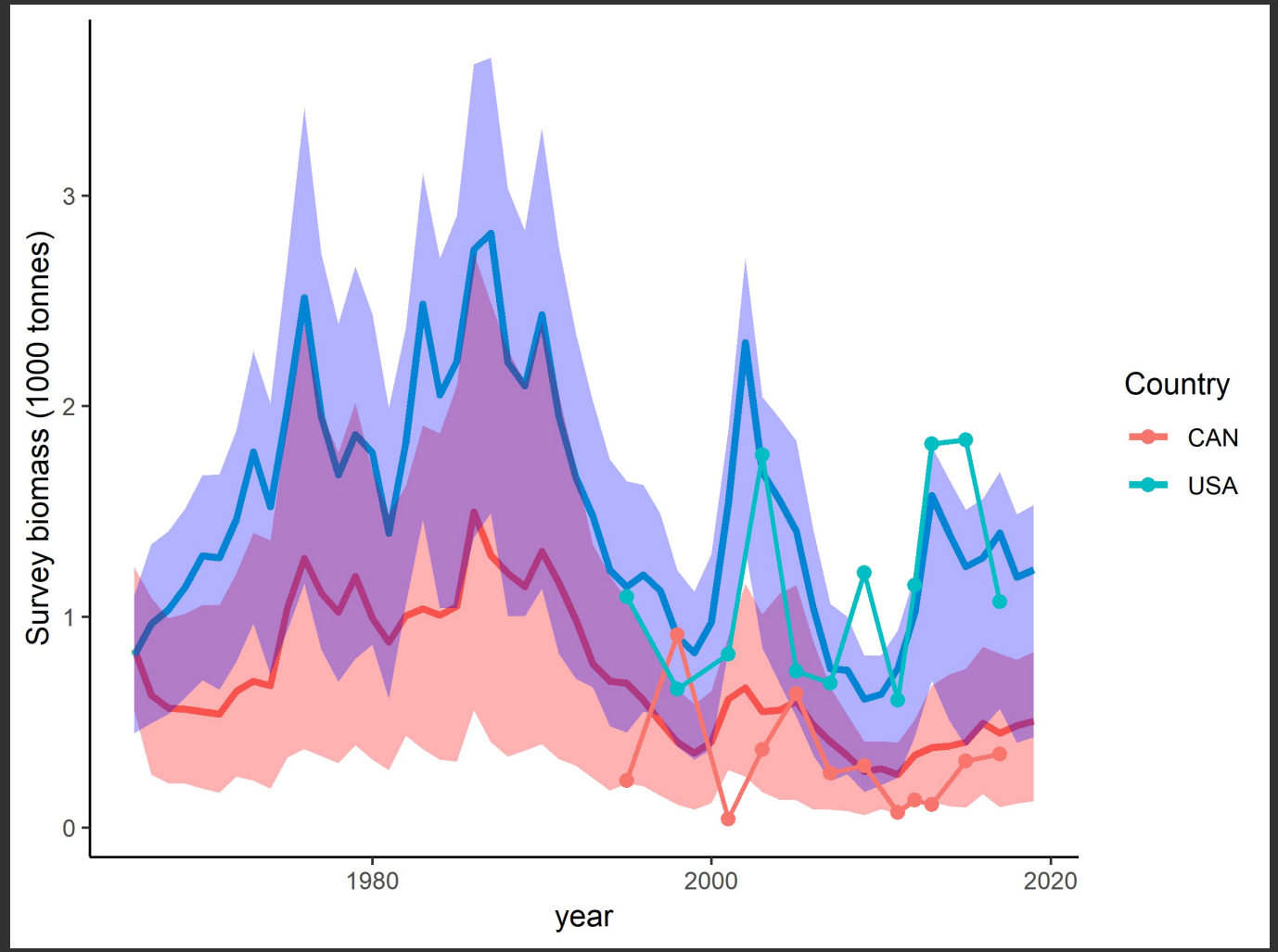
Total spawning biomass with varying movement parameters



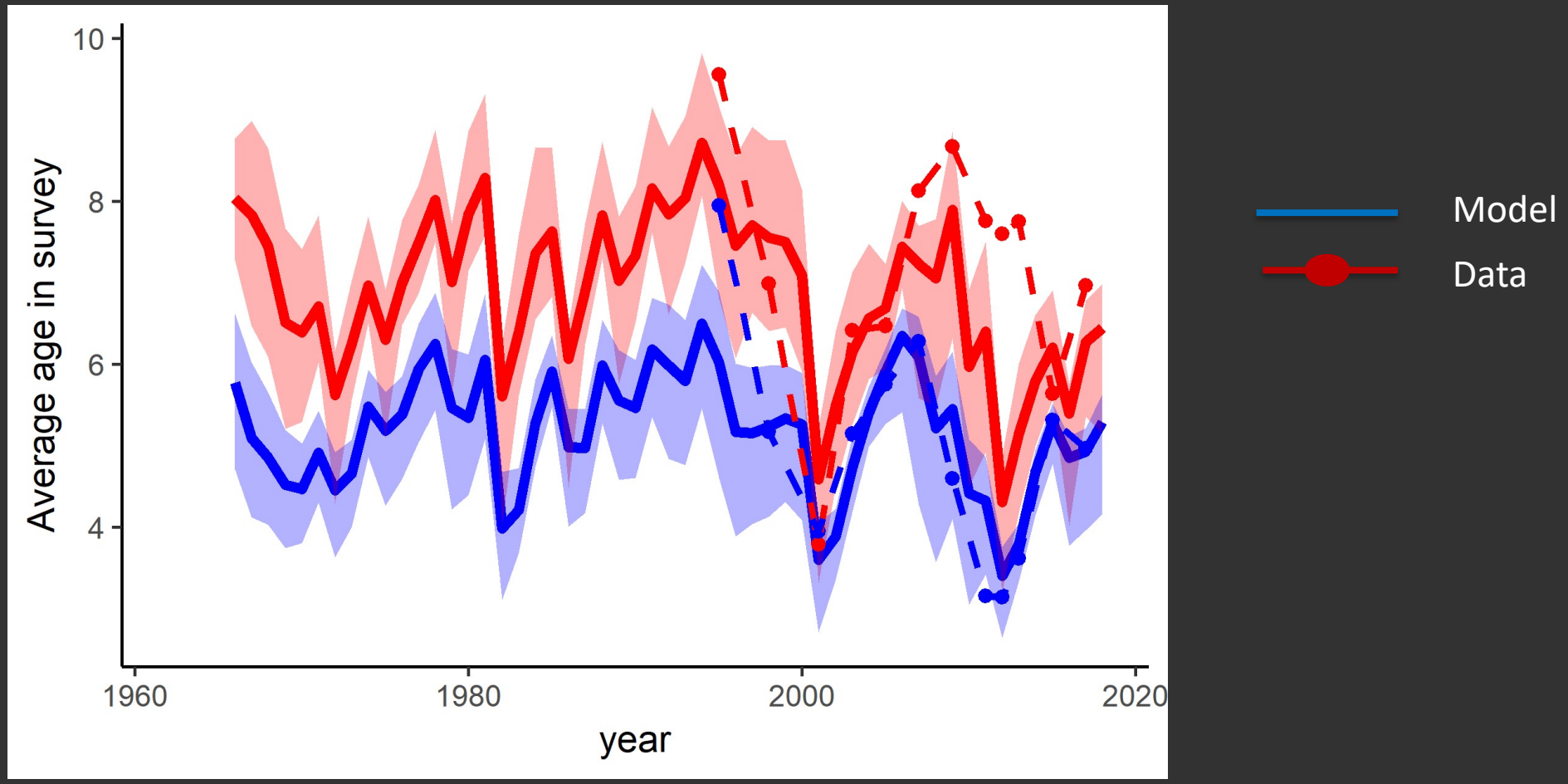
Biomass observed in survey



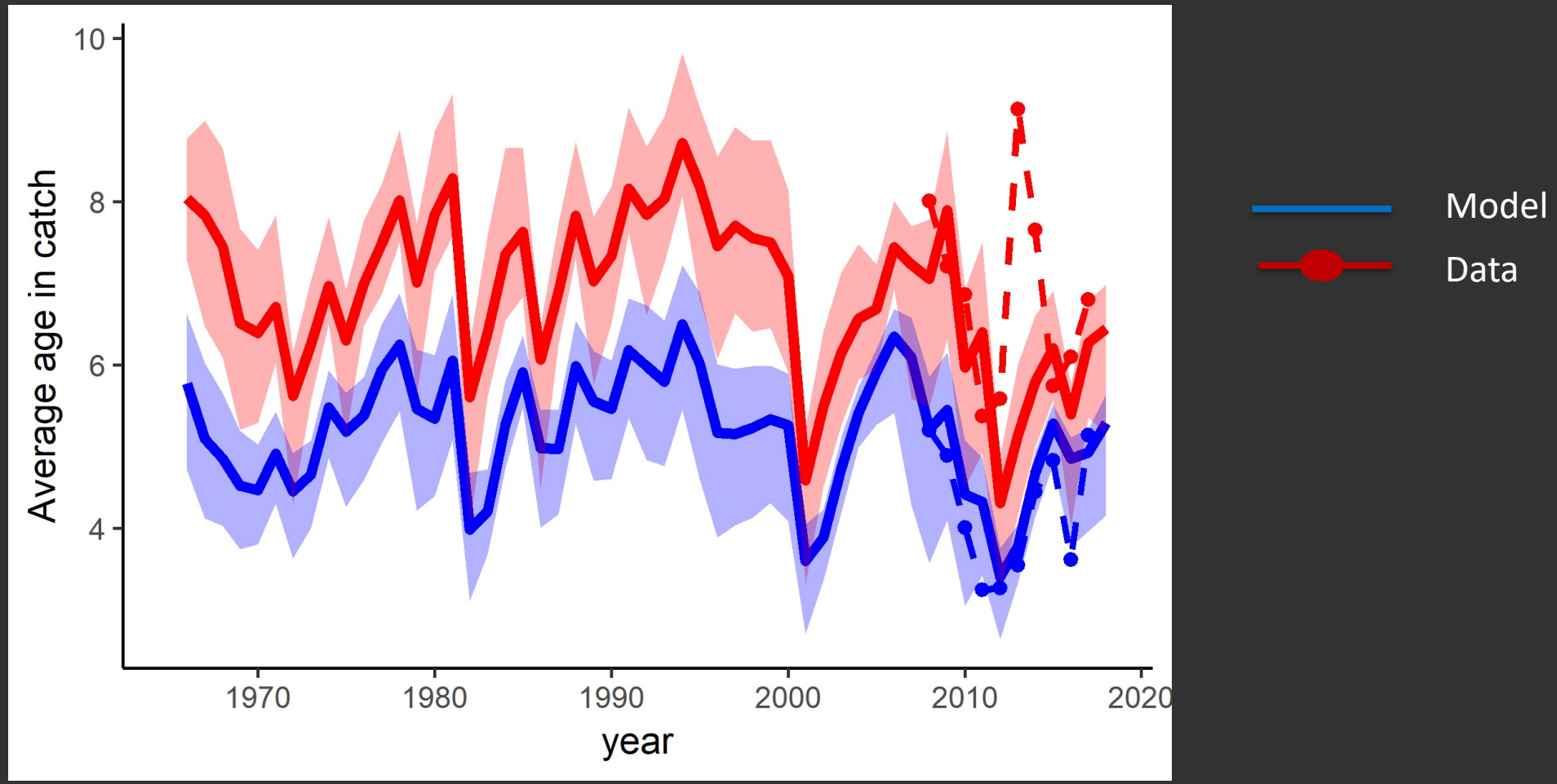
Survey biomass in Canada and USA



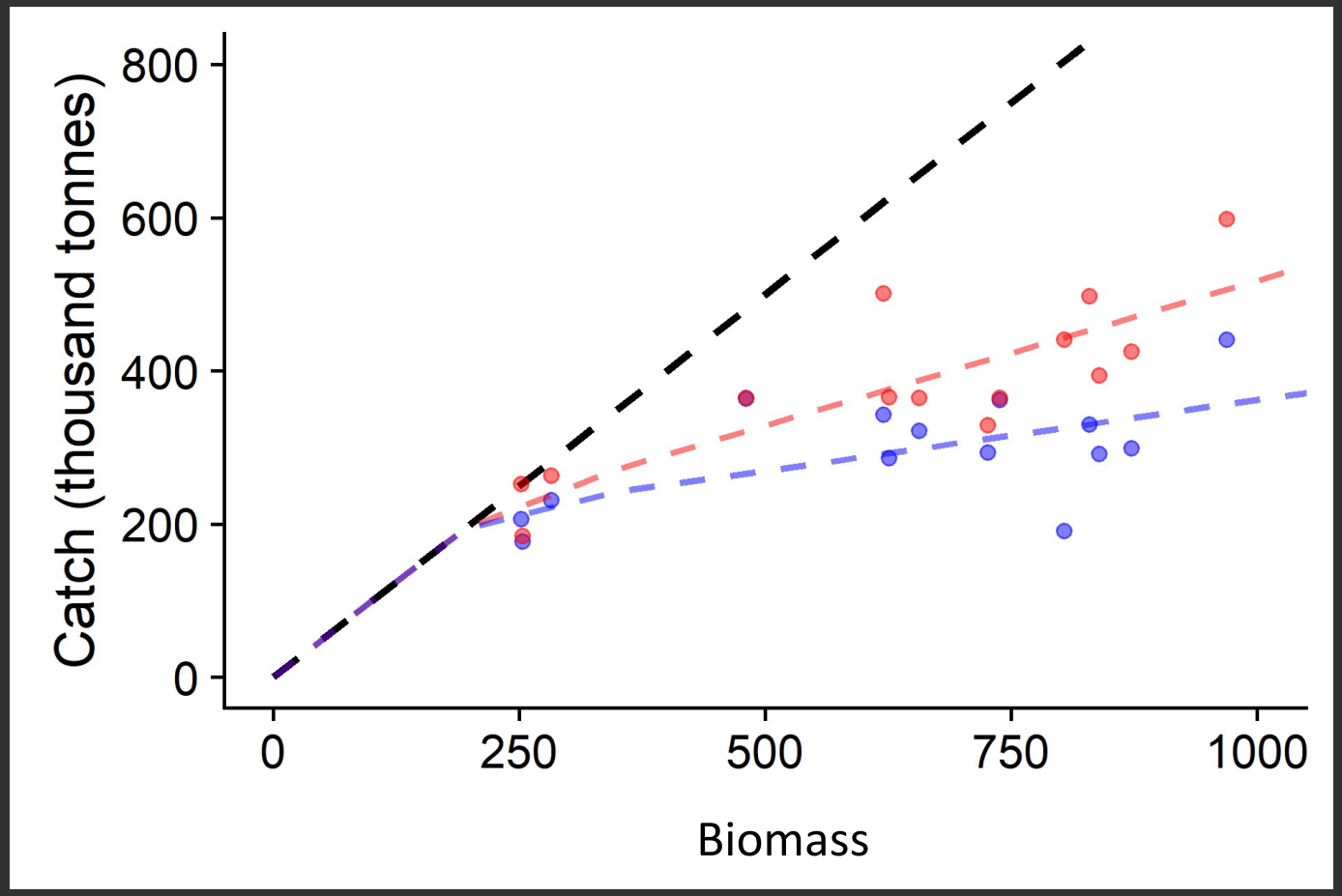
Average age in the survey



Average age in catch



Treaty control rule and alternative catch “buffers”



- Standard HCR
- JMC catch buffer
- Realized catch buffer

Scenarios

- 6 different scenarios (first ones have a median movement rate)

1. Standard HCR
2. JMC catch buffer
3. Realized catch buffer

Movement scenarios (realized catch buffer)

1. Movement scenario 1 (low max movement rate)
2. Movement scenario 2 (high max movement rate)
3. Movement scenario 3 (low min. age to start movement)

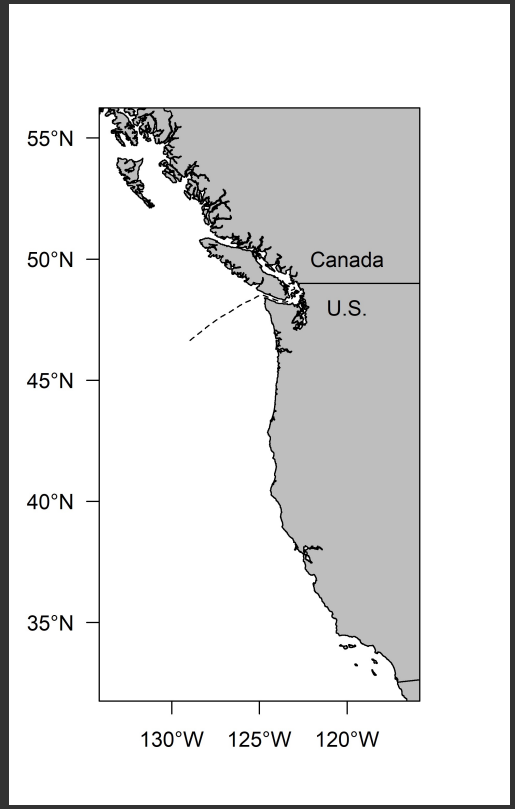
Management objectives identified by MSE working group

Coastwide objectives

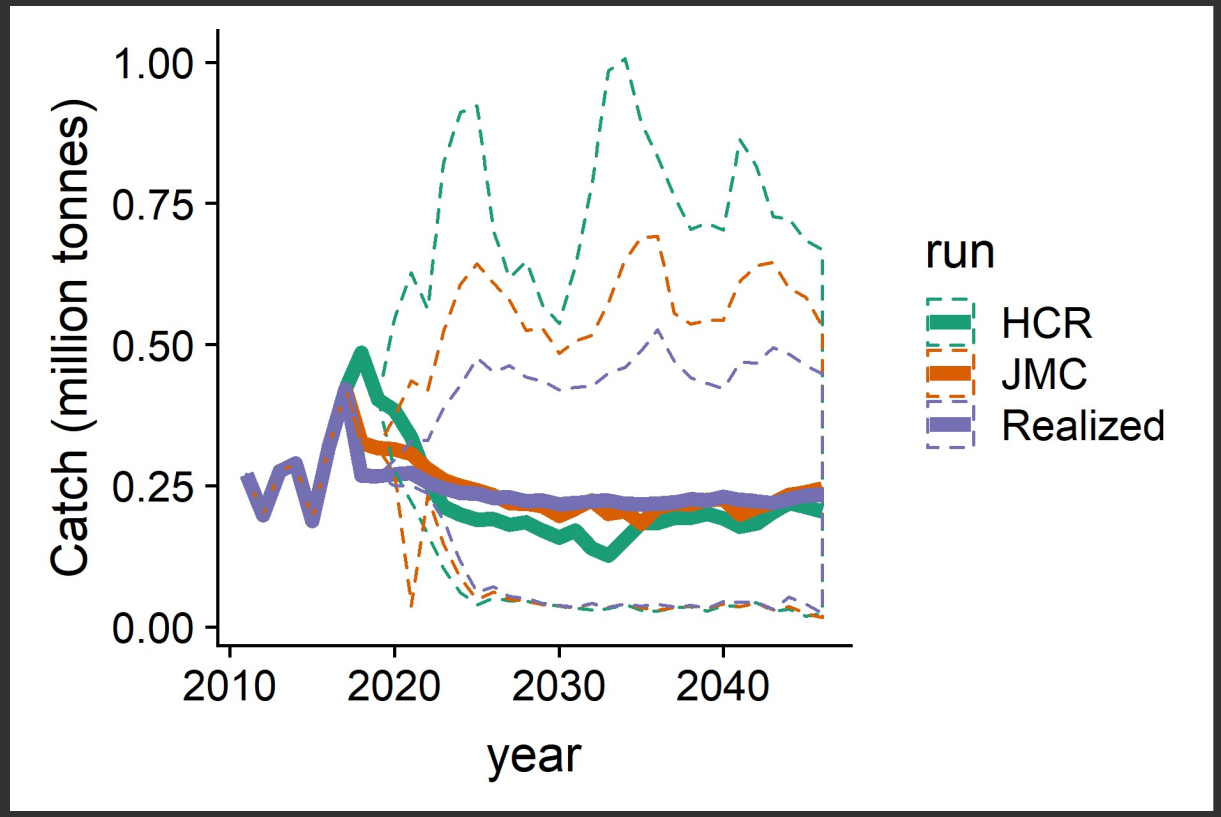
- Minimize risk of severe overfishing and closing the fishery
- Minimize the risk of spawning biomass dropping below the specified management target for >3 years
- Avoid closing the fishery
- Avoid high variability in total catches
- Given above, maintain high average coast wide catch

Spatial objectives

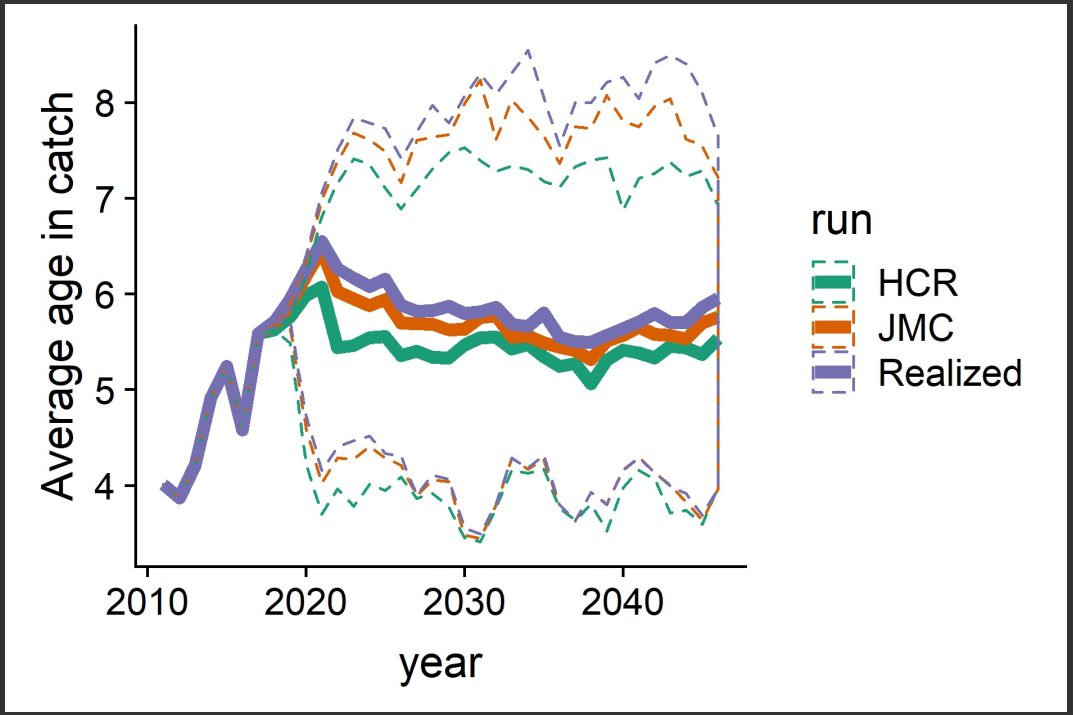
- Maintain enough biomass in both countries to maintain TAC allocation



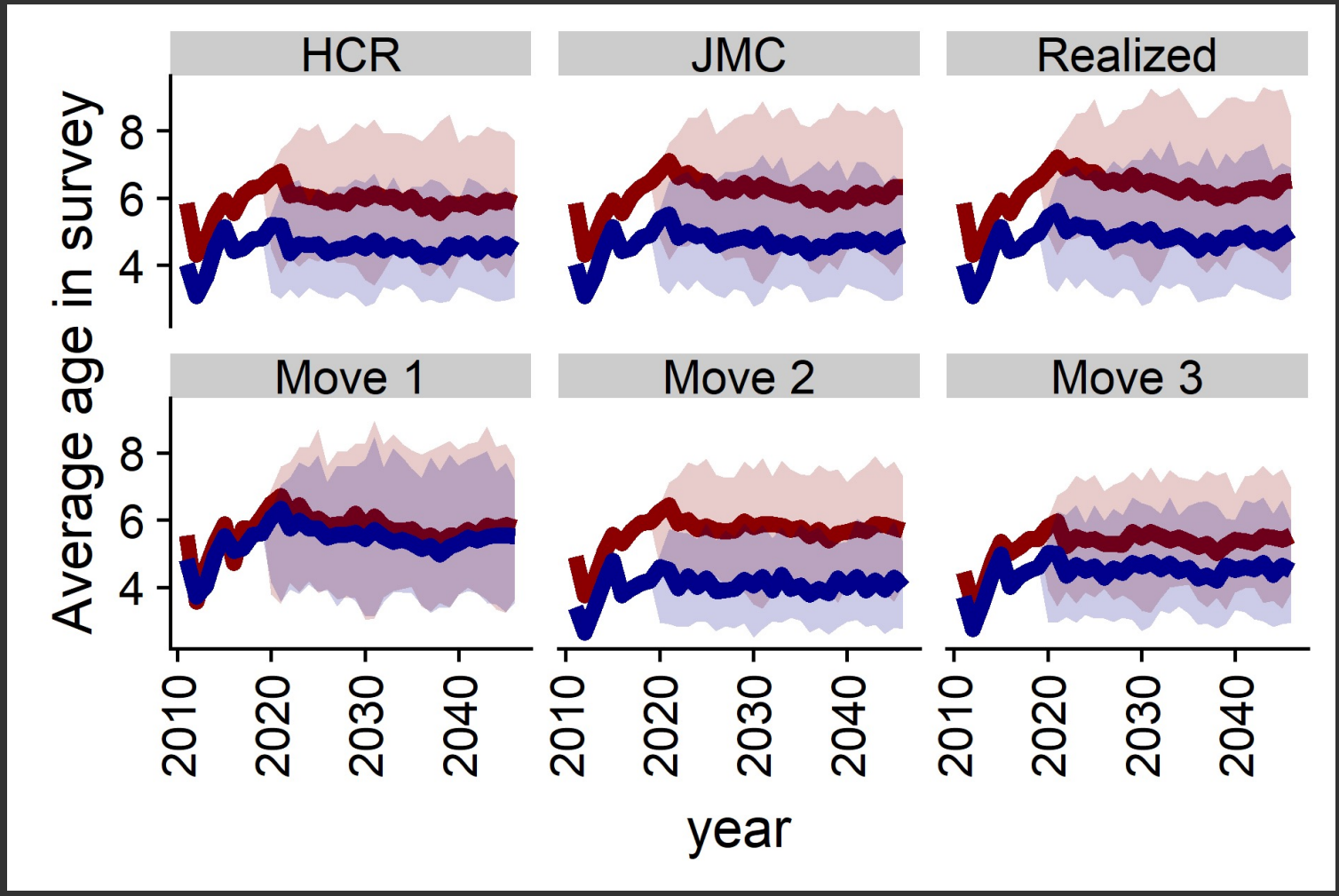
Total catches



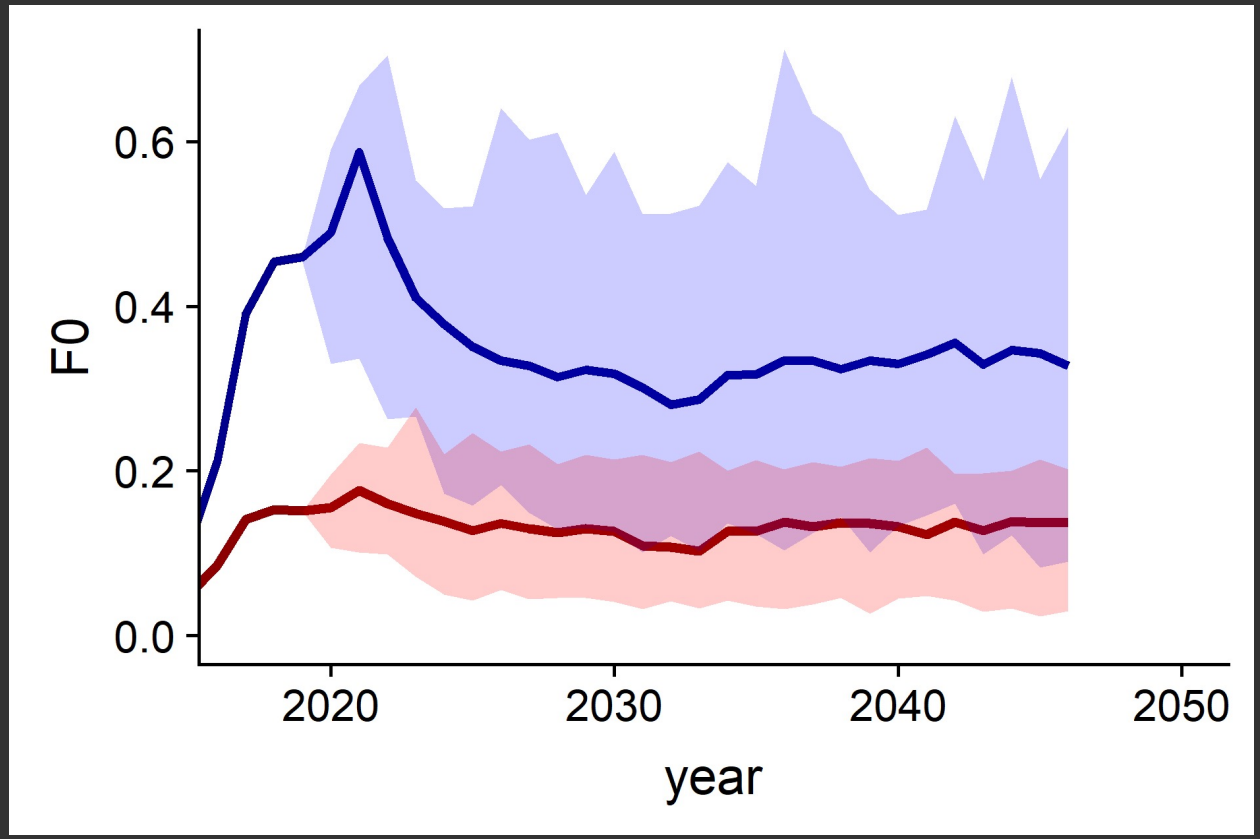
Age composition in the catch



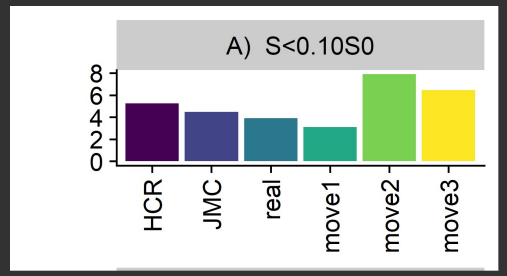
Age composition between the countries



Harvest rates



Performance metrics



Move 1 = Low max movement

Move 2 = High max movement

Move 3 = Low age to start movement

Next steps

- Investigate how movement influences selectivity estimation
- Test catch limits to achieve full TAC utilization for the two countries
- Time and spatially varying biological parameters

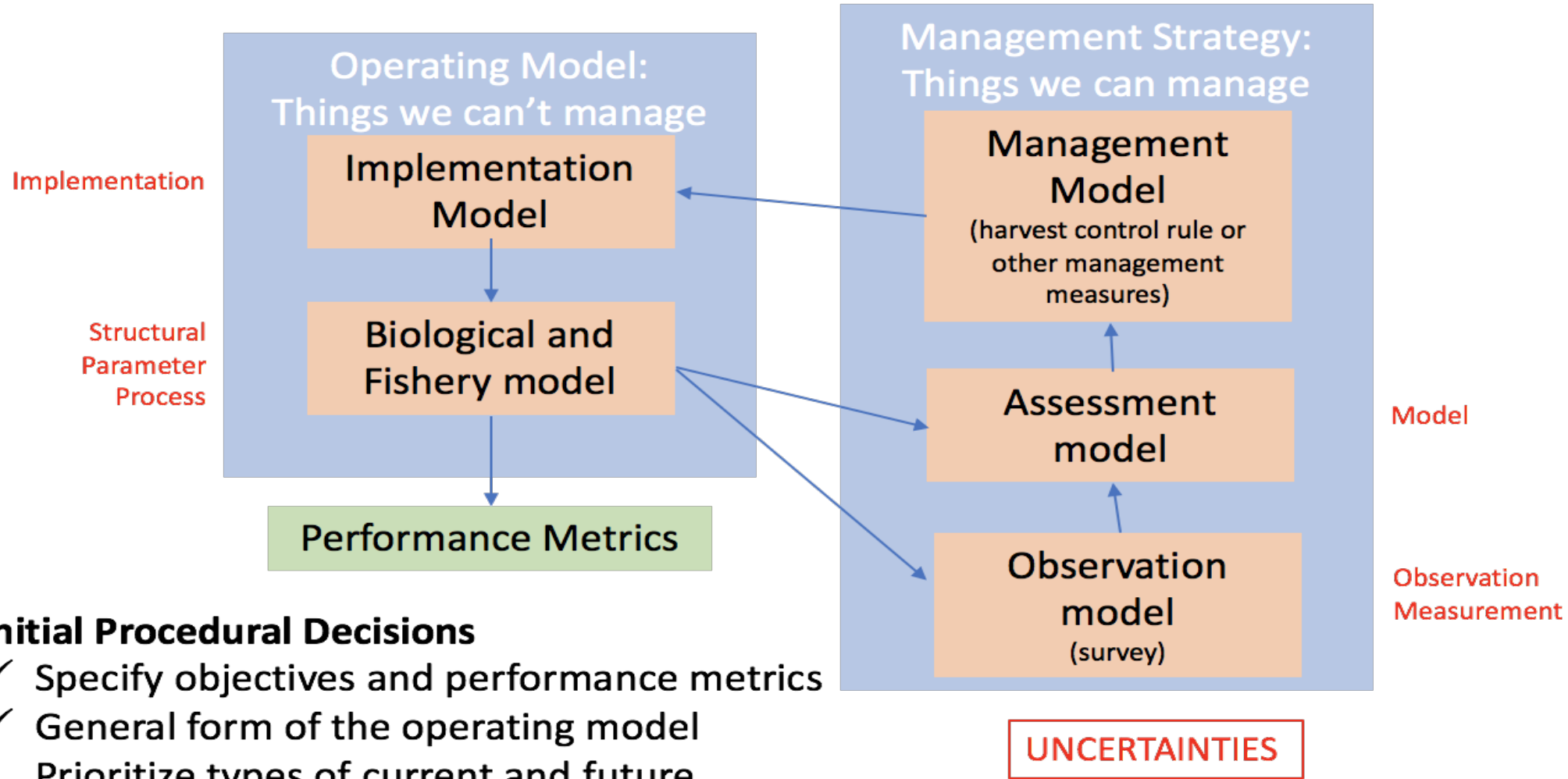
Conclusions

- The spatial structure has little impact on the management objectives
- If movement changes in the future it might influence movement
- Recruitment deviations are the primary drivers of uncertainty

Thank you

Identifying management strategies to test

Management Strategy Evaluation



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Management strategies tested in previous iterations of the MSE

- Status quo HCR
- Catch floors
- Catch ceilings
- Age-1 index

Proposed management strategies to test with spatial operating models

- Status quo HCR: current F_{SPR}=40% with the 40:10 adjustment
- Observation model: acoustic survey frequency
  - Every year
  - Every 2 years
  - Every 3 years
  - Above, with or without an age-1 index
- Assessment model
  - Status quo coastwide
  - “Fleets as areas”
  - Spatial assessment model

Suggestions/topics emerging from the MSEWG discussions

- Proposed implementation alternatives:
  - TAC set at 100 percent of what HCR specifies
  - TAC set at 85 percent of what HCR specifies, with 15 percent carryover
  - TAC set at lower percentage of HCR, reflecting historic decisions made
- Actively targeting certain age classes more heavily than others (e.g 4 year olds)

Are there additional strategies the JMC would like us to explore?

- Control rules or other management measures
- Assessment model structures
- Survey scenarios